EXECUTIVE SUMMARY

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INTRODUCTION

The November 1994 report of the Mayor's Stormwater Task Force examined stormwater issues within Lincoln and recommended that a program of stormwater master planning be implemented for several drainage basins of the City. The Task Force determined that the level of planning for the stormwater management system in Lincoln lagged substantially behind that typically done for other local municipal infrastructure systems. During its investigations, the Task Force discovered that other rapidly growing cities with similar situations have implemented stormwater master planning to address issues and problems associated with substantial growth and changing regulations.

Across the country, long-range stormwater management system planning is being done which takes into account future conditions within entire drainage basins as opposed to incremental planning and construction based on existing or near-term basin conditions. The Beal Slough Basin Stormwater Master Plan (Plan) is the first such effort completed for Lincoln. The planning effort was jointly funded by the City of Lincoln (City) and the Lower Platte South Natural Resources District (LPSNRD). An inter-local agreement provides that the LPSNRD is responsible for creek and major tributary channels, while the City is responsible for the storm drain conduit (storm sewer) and bridge systems. Both agencies have interests in erosion, sediment, and pollution management programs for the land areas which contribute runoff to the stormwater system.

MASTER PLAN OBJECTIVES

The Beal Slough Stormwater Master Plan is a tool for stormwater management within the basin. It is intended to provide a basis for directing investment and administrative decisions for the stormwater management system of the basin. The Plan includes elements to address stormwater issues related to future development as well as elements to address existing issues related to the substantial level of development (in 1997) within the basin.

BASIN BACKGROUND INFORMATION

The Beal Slough Basin is located along Highway 2 in the southern portion of Lincoln as shown on Figure ES-1. The Beal Slough channel begins near the Village of Cheney, at the upper end of the basin, and flows approximately 8 miles northwesterly to Salt Creek. Portions of the basin are outside the City limits, but the basin is entirely within the City's planning and zoning jurisdiction.

Beal Slough is an elliptically shaped, 13.5 square mile watershed. Development originally occurred on the northern slopes of the lower and middle portions of the basin. As shown on Figure ES-1, over 75% of the area is currently developed. The Lincoln-Lancaster County Comprehensive Plan (LLCCP) projects that the basin will be 95% developed by 2015. Only 40% of the area was urbanized when data was gathered by the Federal Emergency Management Agency (FEMA) for preparation of the 1978 Lincoln Flood Insurance Study (FIS). The basin has changed a great deal since then, but current FEMA FIS regulatory floodplain information and maps for Beal Slough are based primarily on the data and analyses from the 1978 FIS.

As with most developing watersheds, urbanization of Beal Slough has changed the volume and rate of storm runoff from intense storm events. That has been documented by accounts of flooding experienced within the basin in 1989, twice in the summer of 1996, and again in May 1998.

On Saturday, July 20, 1996 over five inches of rain fell on portions of south Lincoln. A number of roadways, including portions of Highway 2, residential basements, and recreational areas experienced flash flooding. Flooding occurred near 33rd Street and Pioneers Blvd. and in many areas along Tierra Branch in the Tierra, Williamsburg, Seven Oaks, and Cripple Creek subdivisions.

In order to evaluate past and on-going changes and to develop a basin-wide plan for stormwater management, computer models were developed as basin analysis tools. Figure ES-2 illustrates how Beal Slough was divided into 67 sub-basin areas for purposes of hydrologic modeling.

The hydrologic model developed for the basin was linked to the City's GIS database to utilize the most current basin information available. The hydrologic modeling effort allowed a comparison of 1997 basin storm runoff characteristics with those on which the FIS information for Beal Slough is based. As shown on Figure ES-3, the analysis indicates the 100-year storm run-off rate has increased in the last 20 to 25 years by about 30% in the mid to upper portions of the basin, and by as much as 80% downstream of 27th Street.

KEY ISSUES TO ADDRESS IN THE BASIN

Urbanization has substantially increased stormwater runoff. More frequent and more intense flood events may be the most dramatic and widely recognized result of the changed conditions in the basin. There are also several other related problems and issues of concern that were identified and evaluated during the master-planning effort.

Increased stormwater runoff has caused or contributed substantially to the following problems in Beal Slough:

- Flooding along channels is more frequent and severe than in the past.
- Properties previously free of flood hazard, when upstream property was agricultural, now suffer damage as increased upstream runoff flows across their property toward stream channels. Flow in the channels is wider and higher than it used to be.
- Storm runoff rapidly erodes stripped construction sites, depositing sediment and accompanying pollution in streets, neighboring properties, storm drainage conduits, detention sites, lakes, and streams.
- Removing sediment to prematurely restore capacity multiplies maintenance costs.
- Increased runoff in streams erodes and degrades channels, further deteriorating water quality that flows into downstream receiving waters.
- Sediment from silt-laden, polluted water stifles the natural diversity of aqua-culture species in the streams.
- Eroding channels grow in width to carry greater amounts of flow, exposing buried utilities and threatening the stability of adjacent buildings.
- Growing, eroding channels absorb the limited remaining riparian vegetation, eliminating opportunities for bio-diversity to be perpetuated in the urban environment.
- Costly box culverts, bridges, and storm drainage conduits are overloaded by runoff rates that exceed their design capacity, effective infrastructure service life is shortened and premature expenditure of public funds is required for costly rehabilitation and retrofit remedies.

THE BEAL SLOUGH BASIN STORMWATER MASTER PLAN

Once the combination of issues facing Beal Slough and the project sponsors was identified, approaches to address the individual issues ere evaluated. The Beal Slough Plan includes an ambitious combination of capital cost measures which totals $15.3 million. An overview of the plan features is illustrated on Figure ES-4. The Plan incorporates pro-active measures to stabilize and mitigate, to some extent, the impacts of urbanization in the upper and mid portions of the basin. Since the basin is currently more than 75% urbanized, the Plan also includes many re-active measures to arrest some irreversible effects of basin changes which have occurred in the past. Specific capital improvement components identified for the lower and middle portions of the basin are shown. Seven subareas in the upper portion of the basin are delineated on Figure ES-4. Implementation of regional storage within subareas A, D, E, and G could substantially contribute to reduction of 1997 100-year flow rates towards the targeted Master Plan 100-year flow rates as shown on Figure ES-5.

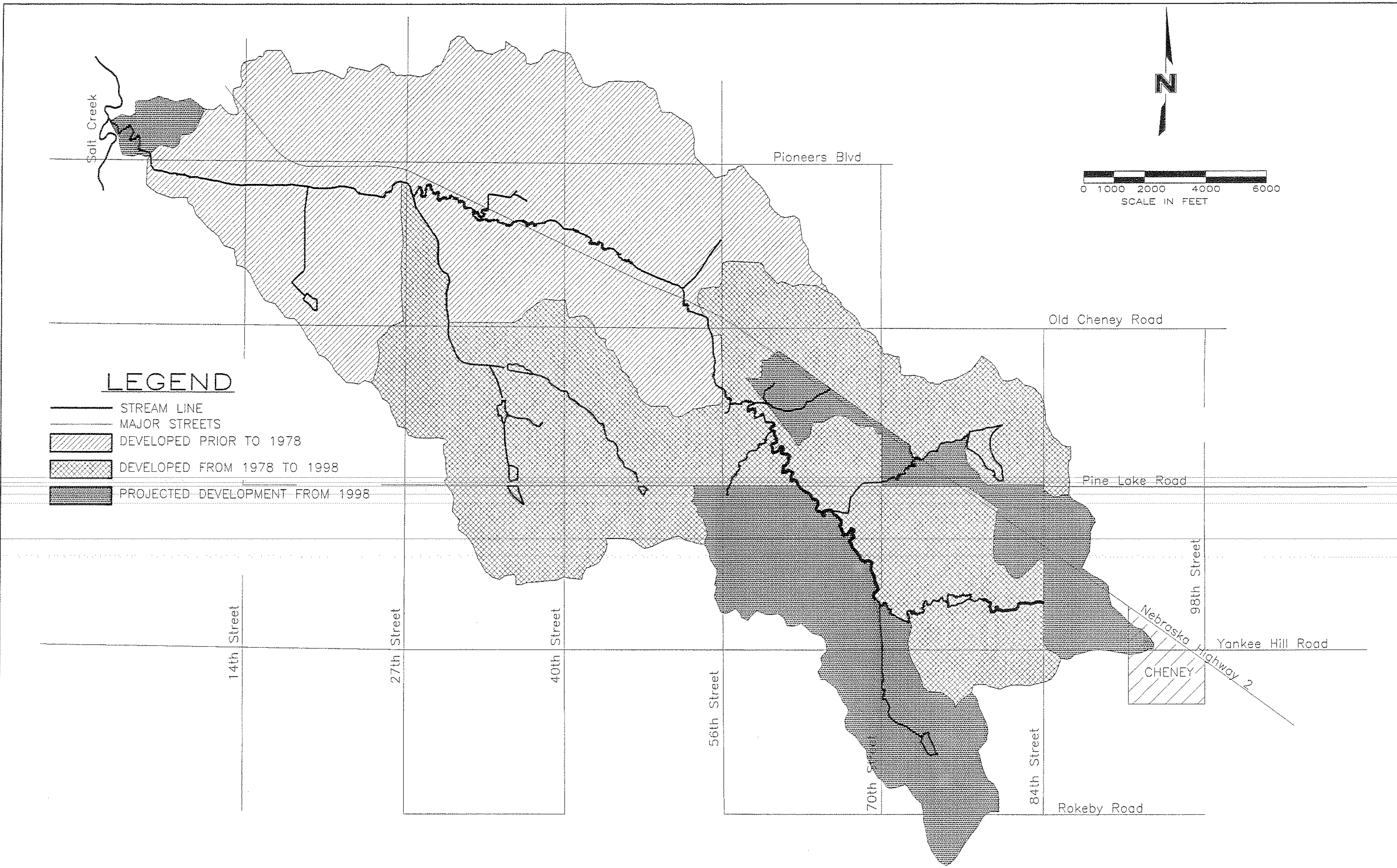
The Plan includes capital cost elements for water quality and stream stability, traditional conveyance improvements, and proposals for stormwater storage to reduce existing and projected peak rates of flow in the upper and middle Beal Slough. Figure ES-5 is a graph which shows the reduction in 100-year peak flow rates which the Plan could achieve. In general, the graph shows that the Plan could reduce the peak flow rates upstream of 38th Street to approximately those published by FEMA in the 1978 FIS. Downstream rates of flow would be reduced by about 10%, and would still be substantially greater than the FIS rates. Consequently, most of the Plan elements targeting the lower portion of the basin are more characteristic of traditional conveyance improvements. Future Master Planning efforts for largely undeveloped basins will rely more heavily on pro-active better management practice (BMP) measures for stormwater management than is currently practical in Beal Slough.

Table ES-1 gives more specific information regarding peak flow reductions targeted by the Master Plan for the upper portions of Beal Slough basin. Tables ES-2a and ES-2b provide target peak flow rates at selected location on the mainstem and tributaries. In Table ES-3, the major capital elements of the Plan are outlined in three groupings of varying priority.

Table ES-1
Subarea 1997 and Target Peak Flow Rates for 2-, 10-, 50-, and 100-year Storms

	2-year		10-year		50-year		100-year	
Subarea	1997	Target	1997	Target	1997	Target	1997	Target
A	390	200	930	470	1390	680	1610	790
D and E	540	65	1240	106	2010	108	2360	109
G	400	220	970	520	1450	750	1710	870

Other elements of the Plan involve application of non-structural watershed BMP's. These will include adoption and implementation of improved City policies and standards as well as development and administration of programs to promote awareness and cooperation of citizens, builders, contractors, engineers, and public officials. Significant benefits within the basin and for downstream neighbors and ecosystems can result by cooperatively improving, as a community, the way we manage and utilize Beal Slough's resources.



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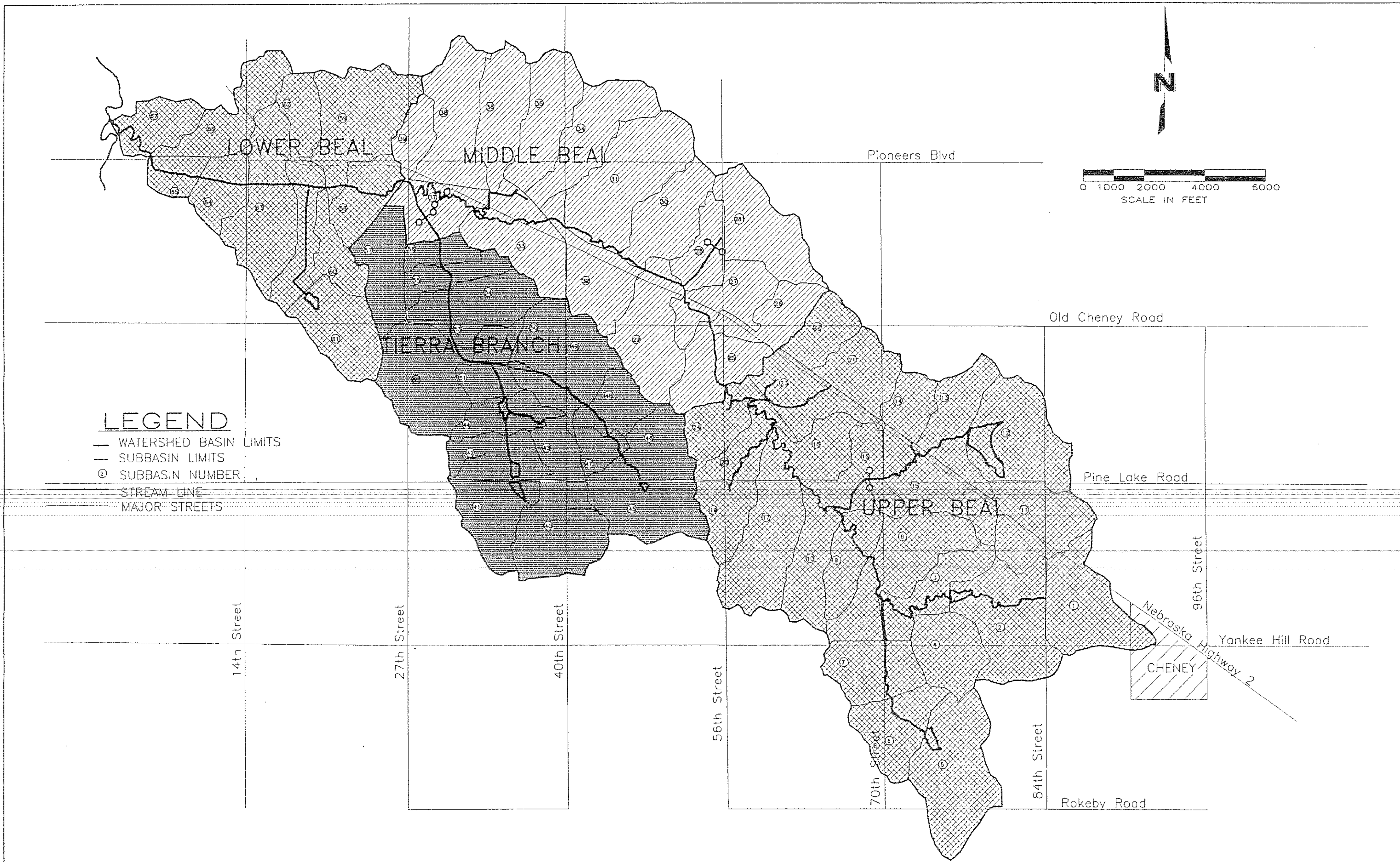
DRAWN BY: JJM DATE: JUNE 1999 REVISIONS:	BEAL SLOUGH MASTER PLAN LINCOLN, NEBRASKA	PATTERN OF DEVELOPMENT MAP	FIGURE ES-1



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BEAL SLOUGH MASTER PLAN

LINCOLN, NEBRASKA

BASIN MAP

FIGURE ES-2

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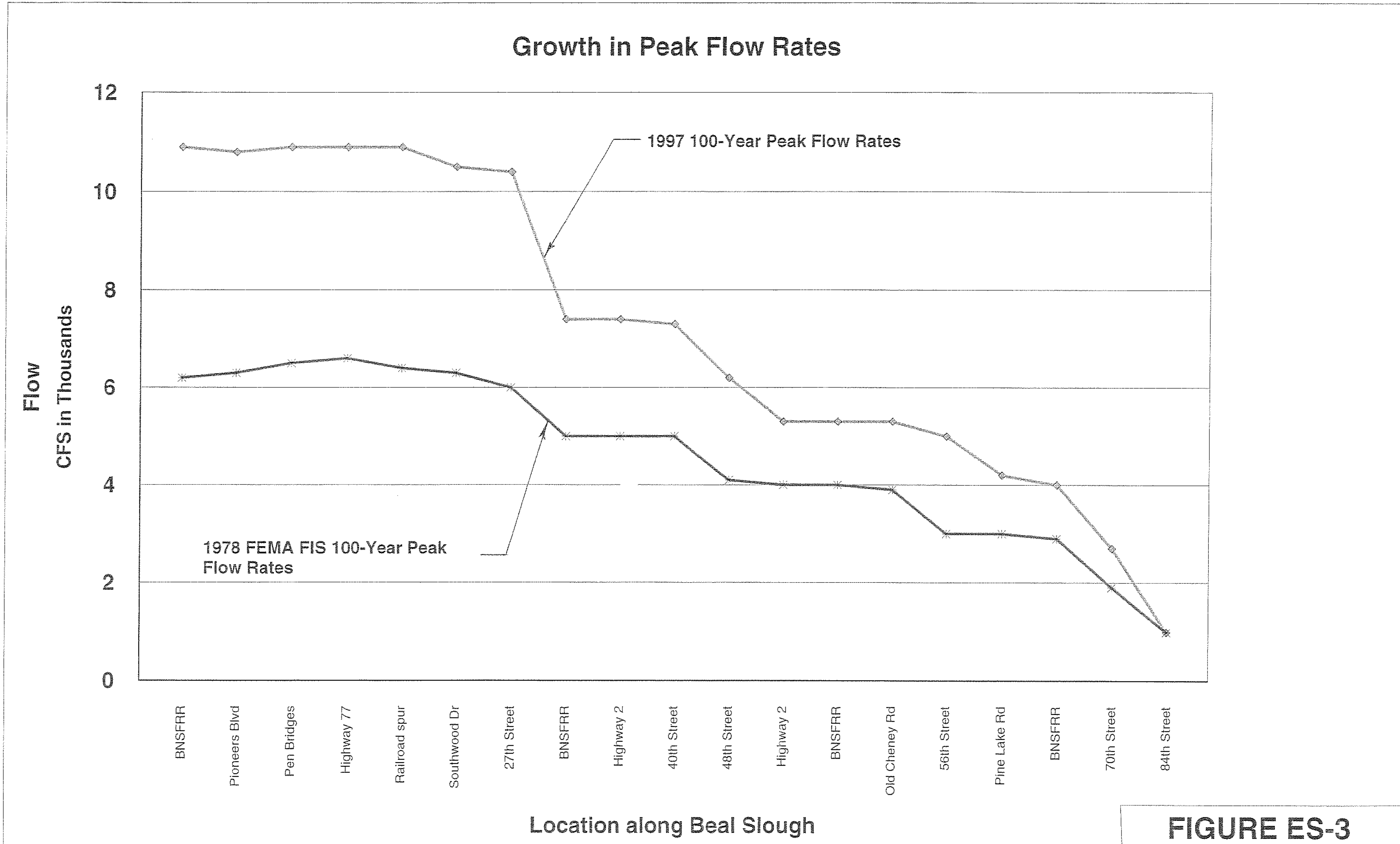
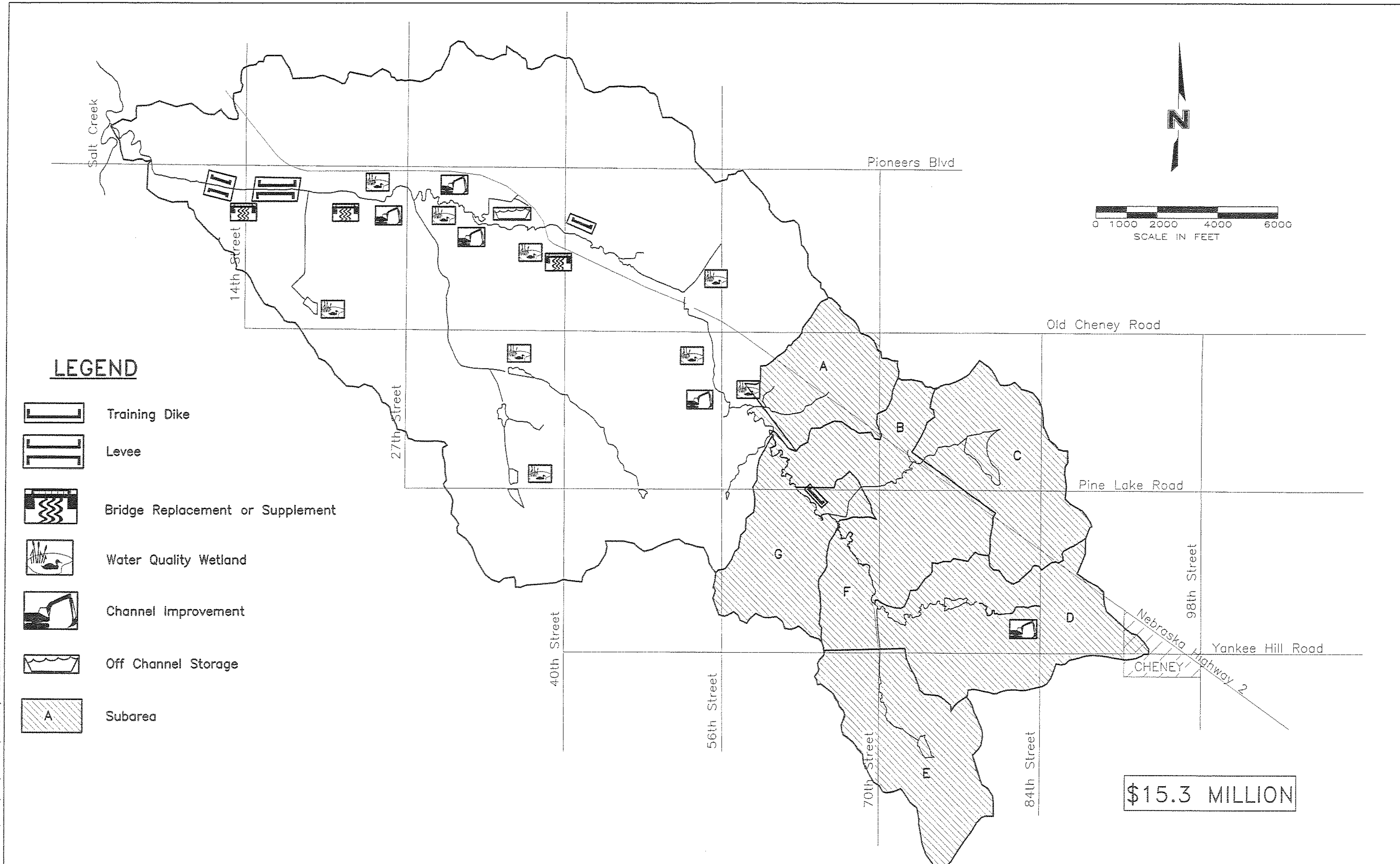


Growth in Peak Flow Rates
Flow
CFS in Thousands
12
10
8
6
4
2
0
1997 100-Year Peak Flow Rates
1978 FEMA FIS 100-Year Peak Flow Rates
BNSFRR
Pioneers Blvd
Pen Bridges
Highway 77
Railroad spur
Southwood Dr
27th Street
BNSFRR
Highway 2
40th Street
48th Street
Highway 2
BNSFRR
Old Cheney Rd
56th Street
Pine Lake Rd
BNSFRR
70th Street
84th Street
Location along Beal Slough

FIGURE ES-3



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BEAL SLOUGH MASTER PLAN
LINCOLN, NEBRASKA

MASTER PLAN
MAJOR CAPITAL COST COMPONENTS

FIGURE ES-4

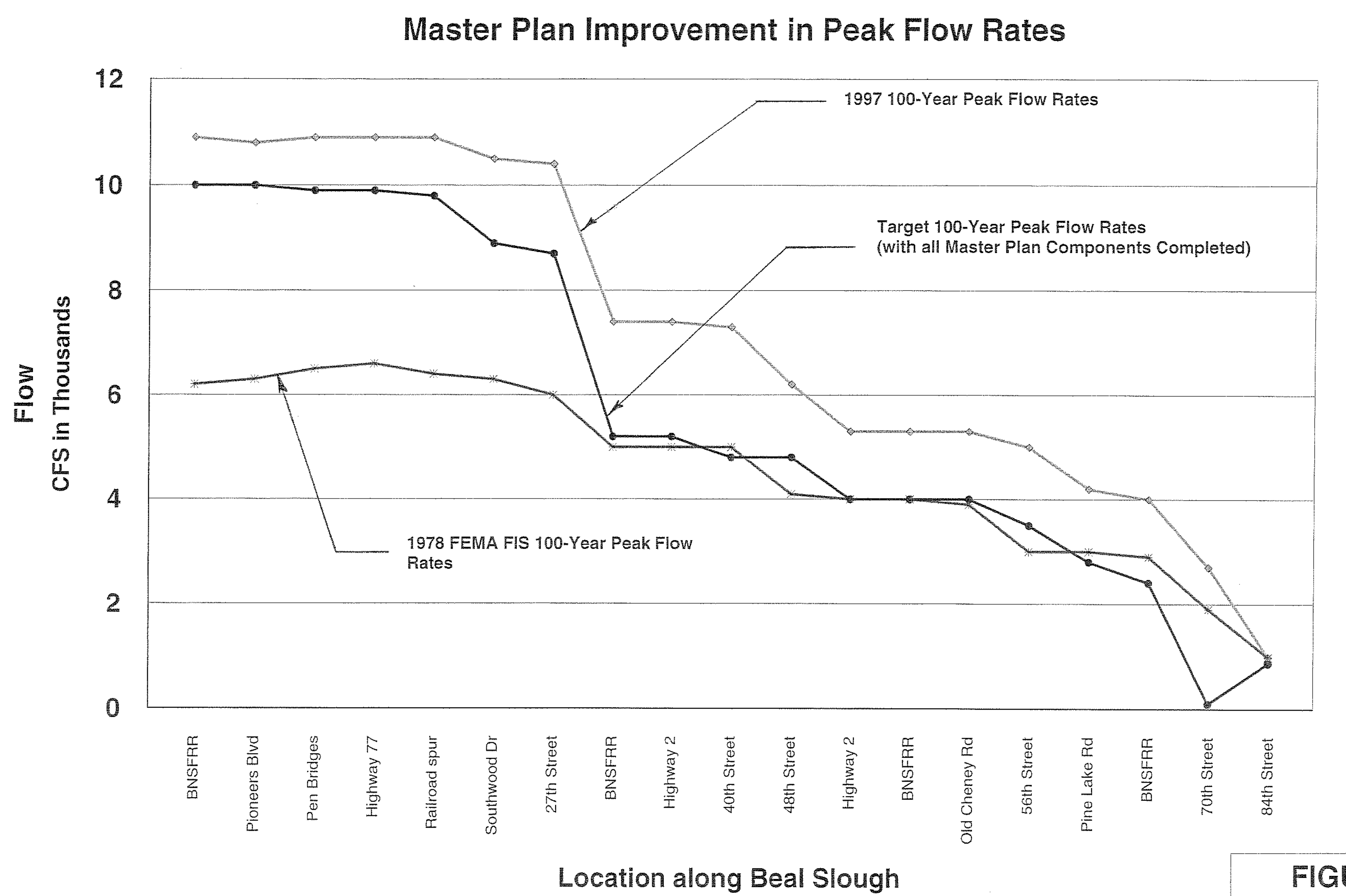
Master Plan Improvement in Peak Flow Rates
Flow
CFS in Thousands
0
2
4
6
8
10
12
1997 100-Year Peak Flow Rates
Target 100-Year Peak Flow Rates
(with all Master Plan Components Completed)
1978 FEMA FIS 100-Year Peak Flow Rates
BNSFRR
Pioneers Blvd
Pen Bridges
Highway 77
Railroad spur
Southwood Dr
27th Street
BNSFRR
Highway 2
40th Street
48th Street
Highway 2
BNSFRR
Old Cheney Rd
56th Street
Pine Lake Rd
BNSFRR
70th Street
84th Street
Location along Beal Slough

FIGURE ES-5

Table ES-2a
Target Peak Flow Rates at Selected Locations on the Mainstem

Location	Master Plan Element Name	Cumul. Area (sm)	2-Year Event cfs	10-Year Event cfs	50-Year Event cfs	100-Year Event cfs
84th Street	84th	0.28	260	540	780	880
70th Street	A	1.76	70	110	110	110
BNSFRR	BNSF64	3.48	600	1400	2000	2400
Pine Lake Road	PineBx	4.03	680	1500	2300	2600
56th Street	56thBr	5.13	870	2000	2900	3400
Old Cheney Road	55OldC	5.30	970	2300	3300	3900
BNSF/Hwy2 Bridge	BNRR	5.48	970	2300	3300	3900
48th Street	48thBr	6.05	1200	2700	4100	4800
40th Street	40thSt	6.93	230	890	2500	2500
Supplemental Box Culvert	40SUPL	N/A	1100	2300	2200	3100*
Hwy2/BNSF Bridge	BNRR38	6.93	400	1200	2900	2900
Beal Slough	R31	8.12	1900	4000	4300	4900
27th Street	27thSt	11.35	3000	6400	8000	8700
Southwood Drive	Southw	11.69	3000	6400	8100	9000
Highway 77(14th St.)	Hwy77	12.96	3200	6900	9000	10000
Penitentiary Bridges	Pen RR	13.09	3200	6900	9000	10000
Pioneers/BNSF Br.	Pionee	13.38	3200	6900	9100	10100
Mouth at Salt Creek	R61	13.51	3200	6900	8700	9600

*Under 1997 and FIS (1978) conditions, as indicated in Table 1-10 of Section I Basin Evaluation, flow through this Master Plan supplemental culvert would pass through the 40th Street and Highway 2/BNSF structures. For purposed of comparison with Table 1-10, add 3100 cfs to the 40th Street and Highway 2/BNSF structure 100-year event rates of flow in this table.

Table ES-2b
Target Peak Flow Rates at Selected Locations on Tributaries

Location	Master Plan Element Name	Cumul. Area (sm)	2-Year Event cfs	10-Year Event cfs	50-year Event cfs	100-Year Event cfs
Yankee Hill Rd	Yankee	0.77	350	800	1100	1300
70th Street	N16	1.13	420	960	1400	1600
Pine Lake Road	N17	1.23	470	1100	1600	1900
Highway 2	22Box	0.13	50	100	110	120
Highway 2	21Box	0.17	60	60	70	70
Pine Lake Road	Pinels	0.26	150	180	300	370
Pine Lake Road	Pineln	0.46	110	270	450	540
Browning Street	Browng	0.87	80	270	450	550
Pine Lake Road	EagleC	0.23	200	320	390	430
Fox Hollow Drive	Fhollo	0.42	370	690	870	980
Cripple Creek Drive	CrpCr	0.49	410	770	1000	1100
40th Street	40th	0.77	560	1100	1500	1700
34th Street	Will34	0.96	670	1300	1800	2100
Jane Lane	JaneLn	2.29	870	1800	2600	3000
Old Cheney Road	OldChn	2.34	870	1800	2600	3000
Sequoia Drive	Sequoi	2.63	990	2100	3000	3500
Tierra Drive	Tierra	2.72	1000	2100	3100	3600

Table ES-3

Preliminary Opinion of Approximate Cost for Major Capital Components[1]

Stream Segment	Component Description	Priority Tier One	Priority Tier Two	Priority Tier Three	
1 & 2	Tie-back levees from BNSFRR near the penitentiary to the railroad spur downstream of Southwood Drive			$2,300,000	Develops additional capacity of BNSFRR bridge near the penitentiary and provides 100-year flood protection of the State Penitentiary. Provides 100-year flood protection of the Nash Finch Company warehouse facility, a commercial storage business and the LES substation. Levee construction must be phased to coordinate with Highway 77 bridge replacement.
2	Replace NDOR Highway 77 bridge			$1,100,000	Provides 100-year capacity without overtopping Highway 77. Bridge replacement should be to coordinate with levee construction.
2	Replace Southwood Drive structure			$600,000	Provides 50-year capacity for a collector street
2	Channel improvement below 27th Street Culvert outlet	$500,000			Increases box culvert performance to near 50-year level and provides stable streambed and channel banks
3	Off-channel storage facility and new channel	$1,600,000			Reduces peak flow rates using storage near the Tierra Branch confluence and reroutes flood flows to a stable channel.
3	Overflow channel and channel improvement above 27th Street Culvert	$200,000			Improves channel capacity and reduces water surface profiles near the Tierra Branch confluence.
4	Supplemental culvert under 40th Street and Highway 2, training dike, enlargement of bridge openings at Highway 2 and BNSFRR	$1,600,000			Eliminates mainstem induced flooding of 42 residences north of the channel during 100-year flood. Minor system improvements on Gertie Avenue reduce local flooding ($600,000 minor system improvements included).
7	Training dike at BNSFRR upstream of Pine Lake Road		$300,000		Eliminates bypass that causes frequent flooding of Pine Lake Road and enhances bridge performance.
Multiple	Upper Beal Slough Storage Facilities	$1,000,000	$1,500,000	$1,500,000	Reduces peak flow rates using on-channel storage, working in combination with other facilities to improve capacities of downstream bridges. Provides potential for multiuse benefits.
All	Streambed and streambank stability measures and channel improvements	$1,100,000	$2,000,000		Bioengineering measures including instream practices, streambank treatment, and channel improvements at multiple locations along Beal Slough.
	$15,300,000	$6,000,000	$3,800,000	$5,500,000	

[1] Based on 1999 costs